JPL NO. 9950-612

DRL No. 109
DRD No. SE-2

DOE/JPL - 955404 - 81/1
Distribution Category UC-63

FINAL DESIGN REPORT

DESIGN, FABRICATION, TEST, QUALIFICATION, AND PRICE ANALYSIS OF "THIRD GENERATION" DESIGN SOLAR CELL MODULES

BLOCK IV

JPL Contract No. 955404

October 15, 1981

SOLAREX CORPORATION

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SOLAREX CORPORATION
1335 Piccard Drive
Rockville, MD 20850
(301) 948-0202

The JPL Low-Cost Solar Array Project is sponsored by the U.S. Department of Energy and forms part of the Solar Photovoltaic Conversion Program to initiate a major effort toward the development of low-cost solar arrays. This work was performed for the Jet Propulsion Laboratory, California Institute of Technology by agreement between NASA and DOE.

TABLE OF CONTENTS

1.0 Description of Program

The Solarex Block IV contract calls for the design, manufacture, and delivery of eighteen residential load modules and eighteen intermediate load modules. Common features of both modules include:

- 72 9.5 cm X 9.5 cm Semicrystalline Cells
- Cells - Ti-Pd-Ag front metallization with n/p p+ junction
- Geometrically arranged in 6 X 12 matrix
- 3/16" Sunadex tempered glass superstrate
- Ethylene vinyl acetate as encapsulant with craneglas spacer
- White Tedlar moisture barrier
- Redundant Cell-Interconnect Design which has six pads per cell
- Wraparound Interconnect
- Circuit Board style interconnect with in-plane stress relief feature.
- Two pigtail connections per positive or negative outlet

Features which are different are shown in Table I.

TABLE I - DESIGN FEATURES

	Intermediate Load Module	Residential Load Module
Outside Envelope Dimensions (cm)	63.5 x 120	62.8 x 119.3
Series-Parallel Arrangements	2P - 36S	6P - 12S
Design Voltage (Volts)	14	4.5
Diode Protection	One per two parallel cells	Two per six parallel cells
Support	Aluminum-modified channel	Supplied without frame

A drawing list is included as Sections 7.0 and 8.0. Top Assembly drawings are included in 7.1 and 8.1.

2.0 Program Plan

The program was divided into six tasks:

Task I - Program Management. This task consists of the effort necessary to manage the contract and insure that contract deliverables are on schedule.

Task II - The manufacture, test, and delivery to JPL of the reference solar cells.

Task III - The building, check-out, and de-bugging of a prototype module fabrication machine to test lamination techniques. Complete design drawings for full-scale module fabrication machine.

Task IV - Fabricate, environmentally test, and deliver to JPL ten preproduction modules (five residential and five intermediate load).

Task V - Fabricate and deliver to JPL 26 (13 residential and 13 intermediate load) completed modules.

Task VI - SAMIS/SAMICS support. Effort, computer time and travel necessary to do SAMIS/SAMICS.

3.0 Schedule

The schedule of the program plan (both planned and actual) is shown in Table II. Almost all tasks were delayed. The prime reasons are:

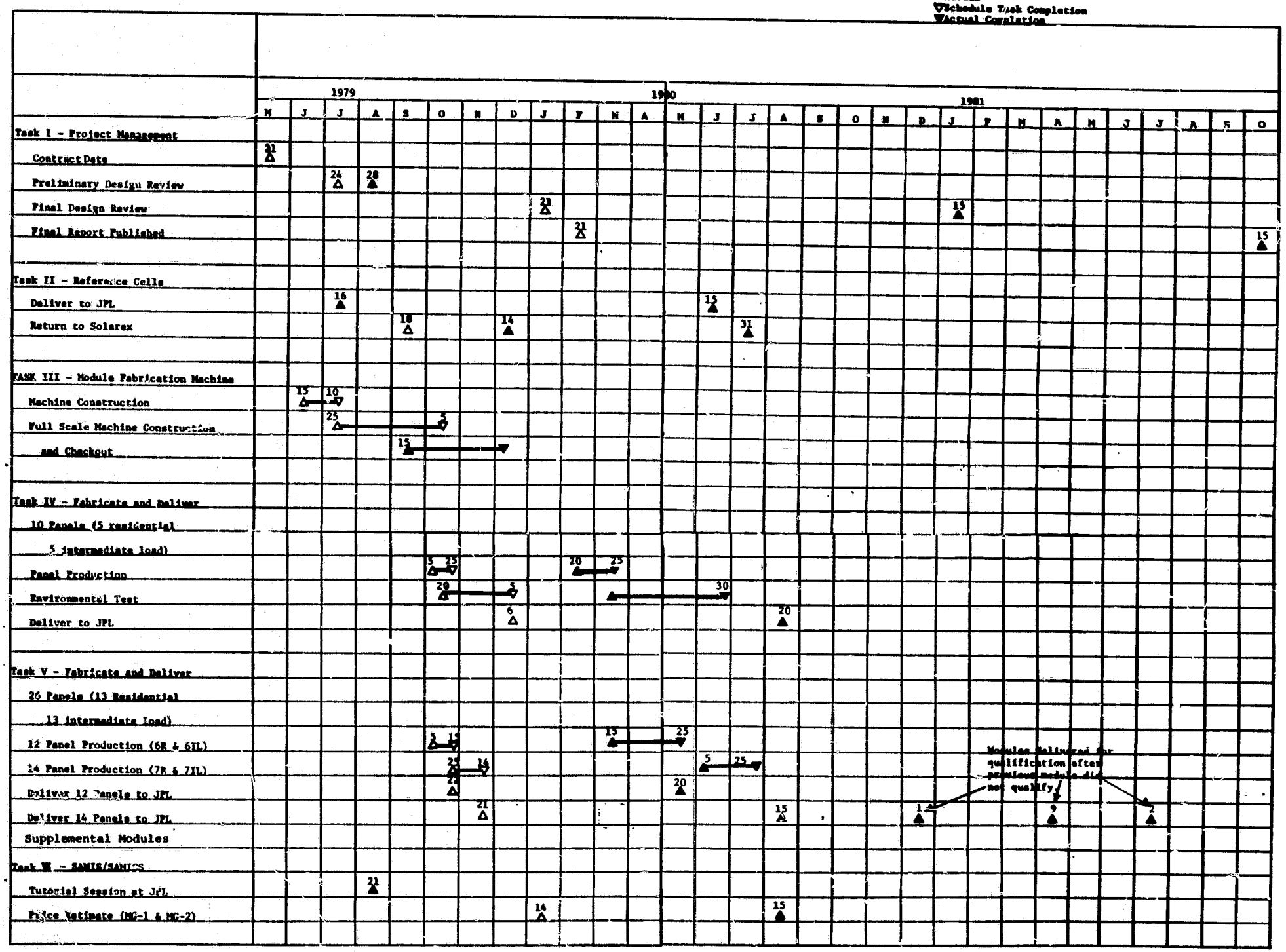
- Start-up problems with cell manufacturing. Cells originally scheduled for the Block IV contract were to be semi-crystalline cells with Ni-Solder metallization. The start-up problems associated with this cell line caused the entire schedule to slip. Later, to prevent any further schedule slip, we made the decision not to use Ni-Solder metallization.
- Various problems that showed up during environmental testing. The Block IV contract was designed to allow both Solarex and JPL the opportunity to environmentally test the modules. In the first test, at both Solarex and JPL, there was a problem with delaminations during thermal cycling. This problem was solved by applying a primer/adhesive (Dupont 68040) to the Tedlar prior to lamination. In December, 1980, a second set of modules was sent to JPL for testing and there were other problems. Specifically there was delamination of the cell back metallization, power loss during humidity testing, and some cell movement during thermal cycling.

  It was determined that the reason for those problems was the cell back metallization that was not resistant to humidity (and subsequently caused delamination and some power loss). The cause for the cell movement during thermal cycling was inadequate EVA cure. The cell back metallization was changed to a Tin-Silver alloy and the lamination procedure was changed to give a more complete cure. At

the time this was done it was not well understood what constituted an adequate cure.

- The third set of panels submitted to JPL exhibited yet another problem. There was EVA/Tedlar delamination that showed up during thermal cycling. However the delamination was primarily restricted to the area around the junction boxes. We determined that the most probable cause of this delamination was the diffusion of outgassing products from the silicon adhesive (that forms the bond between the Tedlar and the junction boxes) to the EVA/Tedlar bond. This weakens the bond enough so that it sometimes delaminates during thermal cycling. A suitable fabrication procedure that works consists of making an initial "priming" application of RTV-102, allowing it to cure, and then applying another coat of RTV-102 both to the primed surface and the junction box.
- The fourth set of panels submitted to JPL passed qualification.
- Throughout the qualification program there has been a problem with ripples or wrinkles in the Tedlar and EVA on the back. Though this problem was not cause for rejection, it nevertheless decreased the cosmetic appeal of the module. Another persistent problem was the lack of a consistently good edge seal. Bubbles tended to form near the edge and the edge was uneven, again decreasing the cosmetic appeal and introducing a possible moisture path. Both of these problems have been solved by a general improvement of techniques during the lamination process. The production run of the modules is much superior in all respects.

△Schedule
▲Actual
▽Schedule Task Completion
▼Actual Completion



4. Environmental Tests

Environmental tests were performed on modules at two different locations. Task IV involved Solarex testing five intermediate load and five residential load modules. JPL also performed environmental tests on a number of modules. The basis for testing is specified in:

JPL-5101-83-"Block IV Solar Cell Module Design and Test Specification for Residential Modules".

and

JPL-5101-16 Rev A - "Block IV Solar Cell Module Design and Test Specification for Intermediate Load Center Applications".

The environmental test procedures consisted of:

- Thermal Cycling - 50 six-hour cycles for $-40^{\circ}C$ to $+90^{\circ}C$.
- Humidity - as specified in above mentioned documents.
- Mechanical Cycling - 10,000 cycles - positive and negative 50 lbs/ft^2 load.
- Twisted Mounting Surface - as specified in above documents.
- Hail Impact - Modules must be capable of withstanding 3/4" diameter iceballs traveling at velocity of 45 mph.

Solarex sub-contracted the thermal cycling, humidity, and mechanical cycling tests to an independent testing laboratory, the Stanford Technology Corporation, of Glenbrook, Conn. Solarex did the twisted mounting surface test at its facility. The hail test was done only at JPL.

5.0 Design Alternations During Pre-Production Phase

5.1 Interconnect Design:

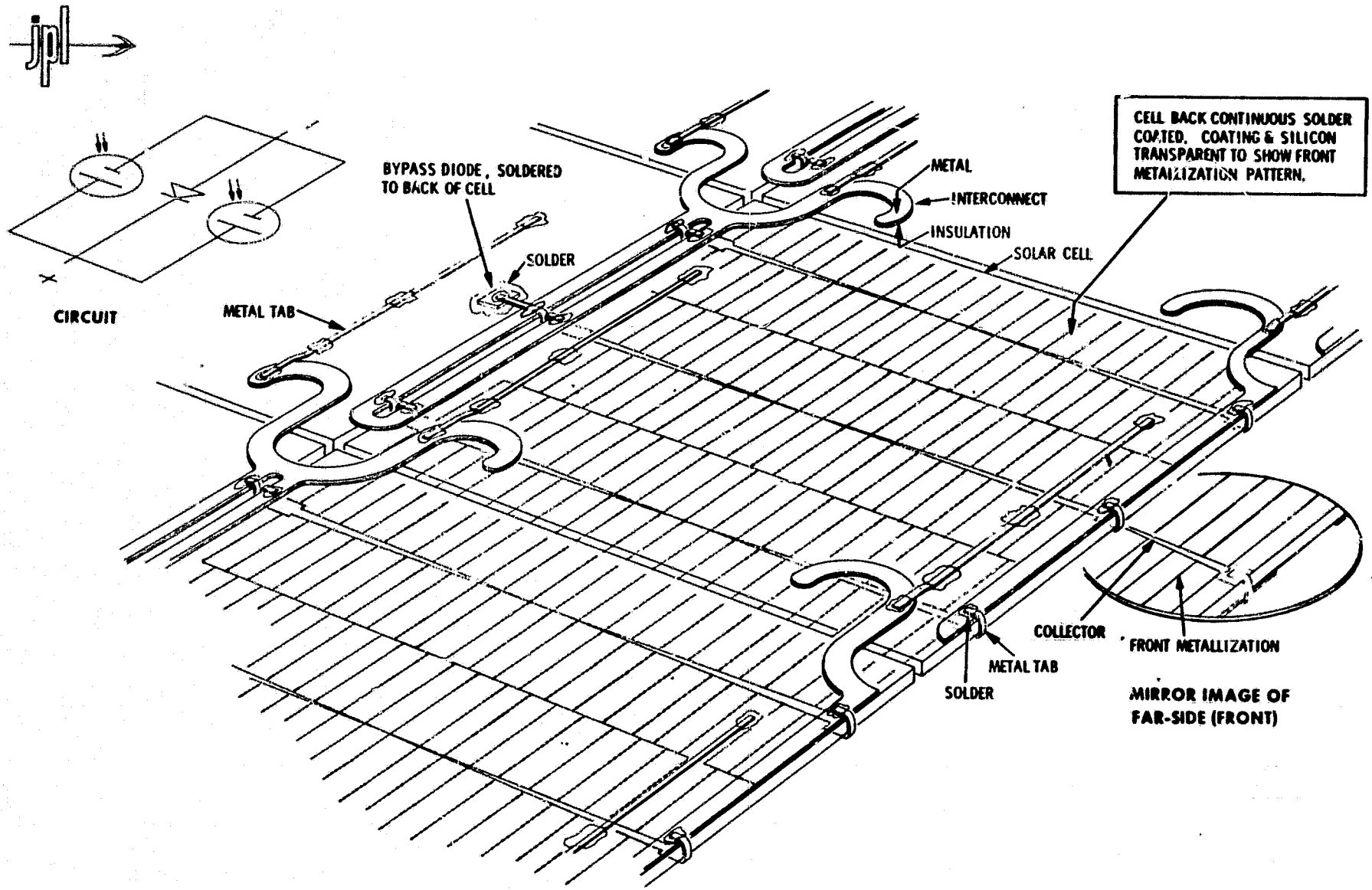
For Block IV, a new type of interconnect (terrestrial applications) was developed. A companion cell design was developed that was compatible with the wraparound concept. A sketch of the interconnect (as drawn by JPL) is shown in Figure 1.

The original idea was that there should be six connections on the front and six connections on the back to provide a highly reliable design. However, with the original design, the interconnect connection to the back of the cell was such that it was about an inch in-board from the connections on the front. We decided to alter the design such that the front and back electrical connections would be about the same relative location on the front and back. The design that is in use is shown on Figure 2.

5.2 Cell Metallization

Two changes were made in cell metallization during the preproduction phase. Solarex's initial intention was to use Ni-Solder. However, problems in transferring this technology from single crystal to the larger 9.5 cm square semicrystalline cells prevented us from achieving this objective.

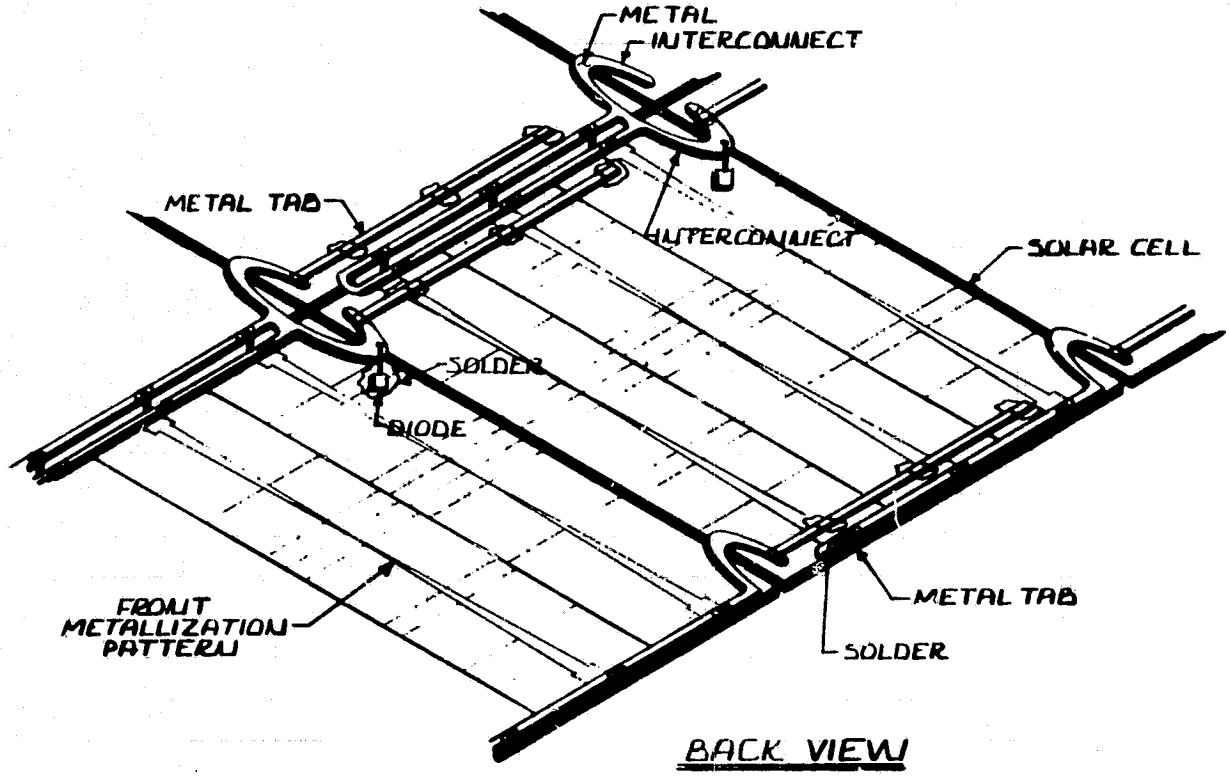
To prevent the schedule from being delayed any longer, we used the tried-and-proven Ti-Pd-Ag front metallization on the Block IV cells. Because of a problem that occurred during humidity testing at JPL in April 1981, a decision was made to use a Tin-Silver alloy back. Production



SOLAREX CELL/INTERCONNECT SYSTEM SHOWN FROM BACK OF CELLS
JPL BLOCK IV MODULES

FIGURE 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



BACK VIEW

FIG. 2 – INTERCONNECT CELL-DIODE ILLUSTRATION

NEXT ASSY	USED ON	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .XX ± .XXX ± ±	CONTRACT NO.	SOLAREX CORPORATION 1335 PICCARD DRIVE ROCKVILLE, MD 20850 (301) 948-0202
APPLICATION		MATERIAL	APPROVALS / DRAWN J Keller / CHECKED	DATE 1-13-81
		FINISH	DO NOT SCALE DRAWING	CELL / INTERCONNECT SYSTEM
				SIZE B · CODE IDENT NO. · DRAWING NO. 969
				SCALE · SHEET OF

Block IV modules have Ti-Pd-Ag fronts and Tin-Silver over Aluminum backs.

Secondly, in keeping with the desire to have a highly reliable and fault tolerant design, we changed the metallization pattern to allow redundant current paths should the primary path be interrupted due to cell breakage or other opens. The mask pattern is shown on drawing B-0813.

5.3 Frame Design - Intermediate Load

The original design was a one-piece design with welded corners. One of the narrow ends was "split" to allow some flexibility to ease the glass into the frame. We had problems with this for two reasons. First, opening the frame to insert the glass called for extraordinary care or the corner welds would develop cracks. Secondly, the welding workmanship of the vendor was not always up to par and despite extraordinary care, cracks still developed. We remedied this problem by making the frame in two pieces with two L-brackets joining the two sides. The resultant frame is a much sturdier, easier-to-construct frame.

The frame and L-Bracket drawings are shown on D-0928-1, D-0929-2 and D-0864.

5.4 Lamination Procedure

Our initial lamination machine and manufacturing procedure was based on the work done by Springborn Laboratories under contract to JPL.

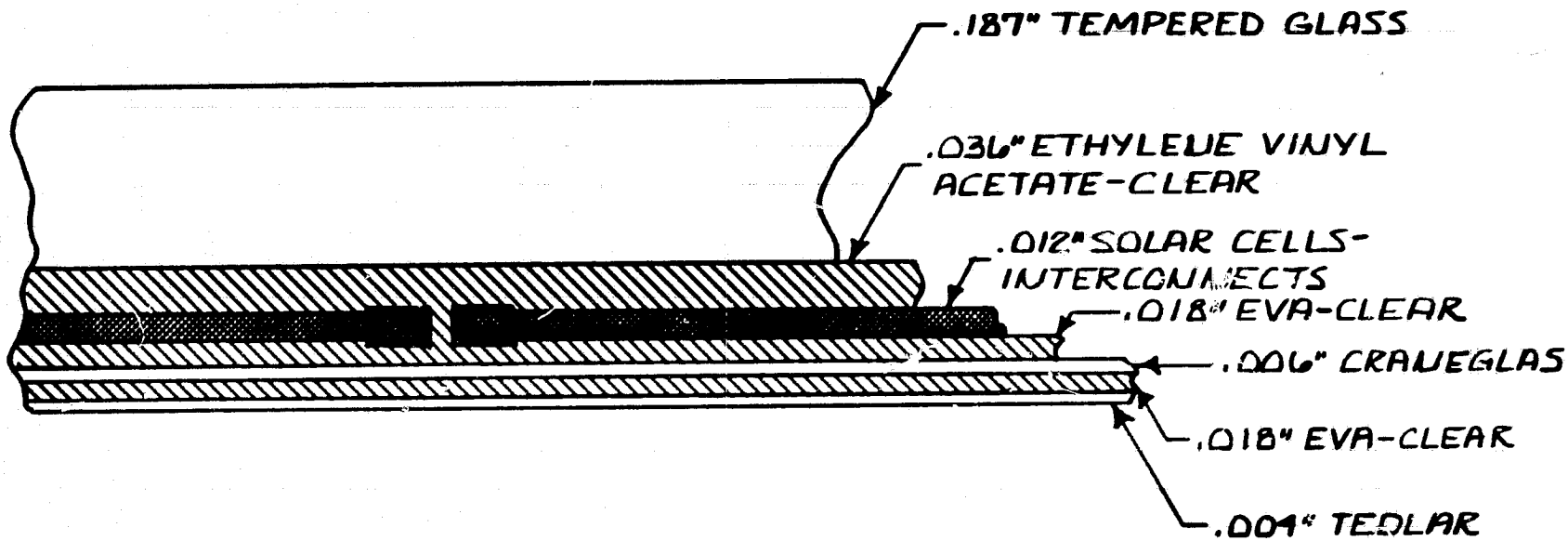
However, we had difficulty in consistently making bubble-free full-size panels. Our first approach was to make the panels in two steps. The first lay up consisted of the glass, two layers of EVA and the cell-interconnect

layer. In the second lamination, the final layer of EVA and one layer of Tedlar were added and put through the lamination cycle. While this approach did achieve a good EVA cure, it had two major disadvantages. Too many cells were broken and the cycle time was excessive. When the modules were subjected to thermal cycling, there was excessive delamination between the Tedlar and EVA.

Our initial approach to resolving these problems was to use much less pressure during lamination. To accomplish this, instead of an air bag technique, we used weights. This decreased the pressure from one atmosphere (about 14.7 psi) to the equivalent of about 0.14 psi. We also introduced a one step lamination procedure. The results were mixed: the cycle time decreased markedly, cell breakage was eliminated but we still had problems with bubbles, especially near the edges. The cosmetic problems with wrinkly backs continued. We tried many variations of lamination methods to improve the quality and found that the best results were attained by using a pressure differential of about 1/2 atmosphere ($\sim$7 psi) with an air bag. We also installed better control and monitoring instrumentation both for the electrical and pressure/vacuum systems.

The procedure that is being used for the production run results in a module that is bubble-free, rarely has cell breakage, has a well-defined, bubble free edge and withstands environmental testing.

Figure 3 shows a sketch of materials used presently.



ENCAPSULATION CROSS-SECTION

FIGURE 3.

6.0 Performance Characteristics

Characteristics of the module as measured or determined by JPL are:

	INTERMEDIATE LOAD	RESIDENTIAL LOAD
NOCT - $^{\circ}$C*	56	56
Avg. Power -@ 56°C-watts	56.0**	56.0***
P min - watts	50.4	50.4
$\Delta V/\Delta T$ - Volts/$^{\circ}$C	-0.0856	-0.029
$\Delta I/\Delta T$ - Amps/$^{\circ}$C	+0.0045	+0.0136

* NOCT Insolation value = 100 mw/cm^2

** Design Voltage = 14.0 Volts

*** Design Voltage - 4.5 Volts

APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED
		A	0865F, 0863D	3-2-81	JFH
		B	0863E, 0865G	3-19-81	JFH

D-0865G Block IV Residential Load
Top Assembly

D-0975B Block IV Residential
Lamination Assembly

D-0871E Block IV Residential Load
Cell Assembly

*B-0872A Solar Cell Tab Assembly

*B-0813A B-4 Solar Cell Mask

*C-0926 Block IV Interconnect

C-0927-1,
-2A Block IV R & L Interconnect

B-0825C Electrical Schematic - Residential Load

*B-0870A Block IV Terminal Box Detail

*B-0879 Identification Label

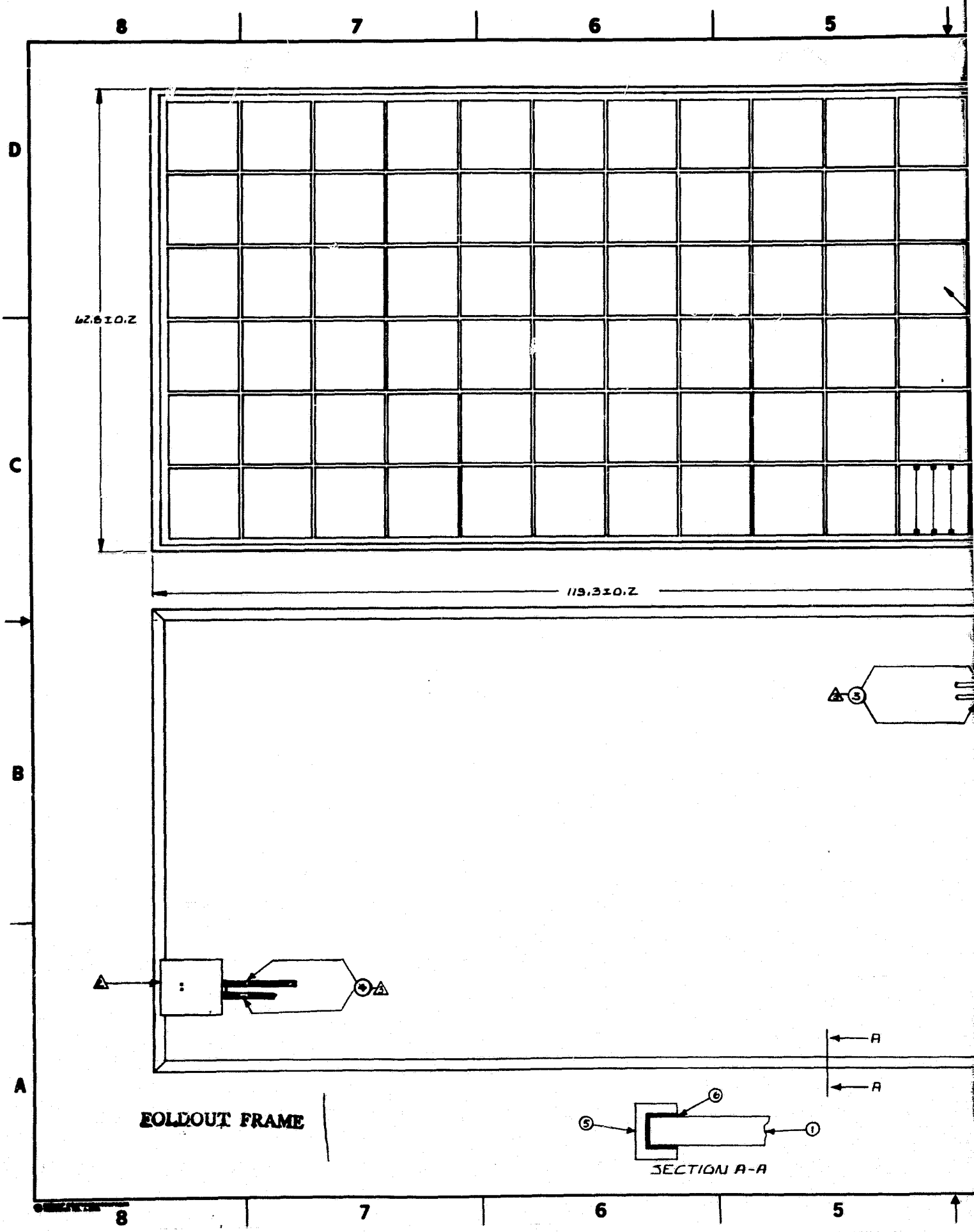
A-0976A Gasket - Block IV Residential

D-0863E Interface Control
Residential Load - Block IV - 2 Sheets

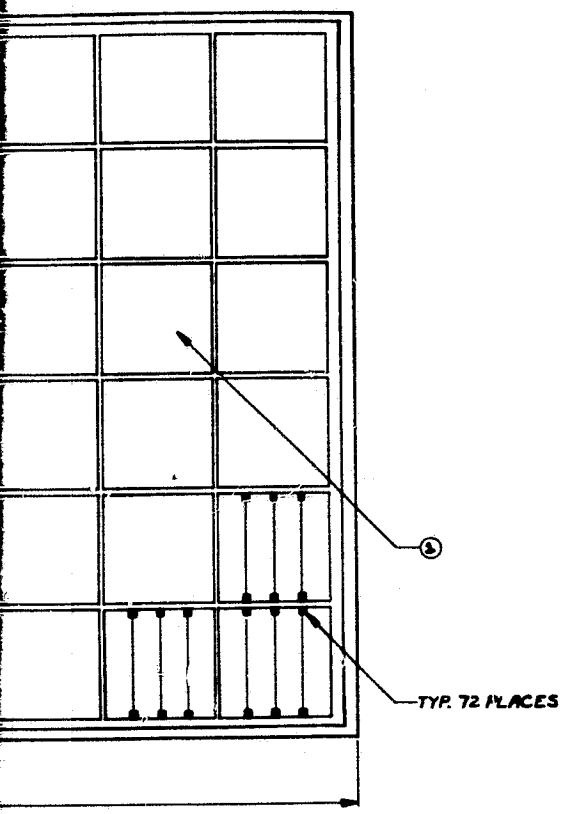
*Applicable to both Residential and Intermediate Modules

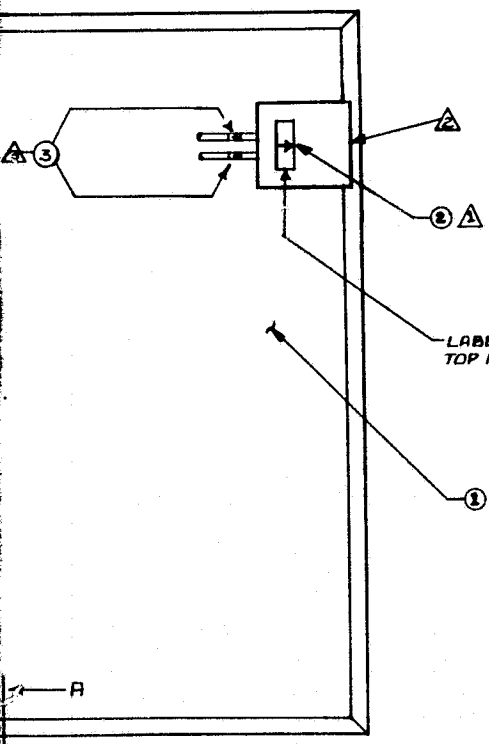
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±	CONTRACT NO.	SOLAREX CORPORATION 1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202	
	APPROVALS DRAWN	DATE	Block IV Residential Load Drawing List
MATERIAL	CHECKED		15
FINISH			SIZE A / CODE IDENT NO. / DRAWING NO. 580-BT-R-B
DO NOT SCALE DRAWING			SCALE / SHEET OF

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. A-7270


8
7
6
5
D
C
B
A
62.6±0.2
119.3±0.2
A
A
SECTION A-A
FOLDOUT FRAME

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	GENERAL REVISIONS	1/9/80	JFH
	B	General Revision	4/10/80	JFH
	C	PROVISION FOR GASKET	11/19/80	JFH
	D	62.8±0.2 WAS 62.2	12/29/80	JFH
		118.3±0.2 WAS 118.7		
	E	GEN. REV.	1/30/81	JFH
	F	ADD PROV. FOR MODIFICATION-LABEL	2/2/81	JFH
	G	CHANGE ⚠ NOTE	3/19/81	JFH





ASSEMBLY NOTES

⚠1 ID LABEL - IN MODEL NO. BLOCK TYPE FOLLOWING INFO:
580-BK-40-250 V MM.
WHERE M IS REVISION NUMBER ON DRAWING LIST 580-BK-R

IN SERIAL NO. BLOCK TYPE FOLLOWING INFO:

XXXXXX - YY - ZZ

XXXXXX = NO ASSIGNED FROM SOLAREX KESTER CONTROL LOG

YY = CALENDAR YEAR

ZZ = SEQUENTIAL WEEK OF YEAR

PEEL OFF BACK PROTECTIVE PAPER AND APPLY ON POSITIVE TERMINAL BOX WITH TOP IN DIRECTION SHOWN

⚠2 GASKET TRIMMED TO FIT FLUSH WITH TERMINAL BOX

⚠3 APPLY POLARITY LABELS

FOLDOUT FRAME 2

NO.	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER
6	A/R		RTV-108	ADHESIVE	G.E.
5	1		0976	GASKET	PAWLING RUBBER CO.
4	2		LABEL	NEG	SOLAREX
3	2		LABEL	POS	SOLAREX
2	1		RID-0879	IDENTIFICATION LABEL	SOLAREX
1	1		RID 0975	LAMINATION ASS'Y	SOLAREX

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN cm. TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ±0.1 .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN A.MEAGHER	11/29/79
CHECKED J.L.J.	12/1/79

Section 7.1

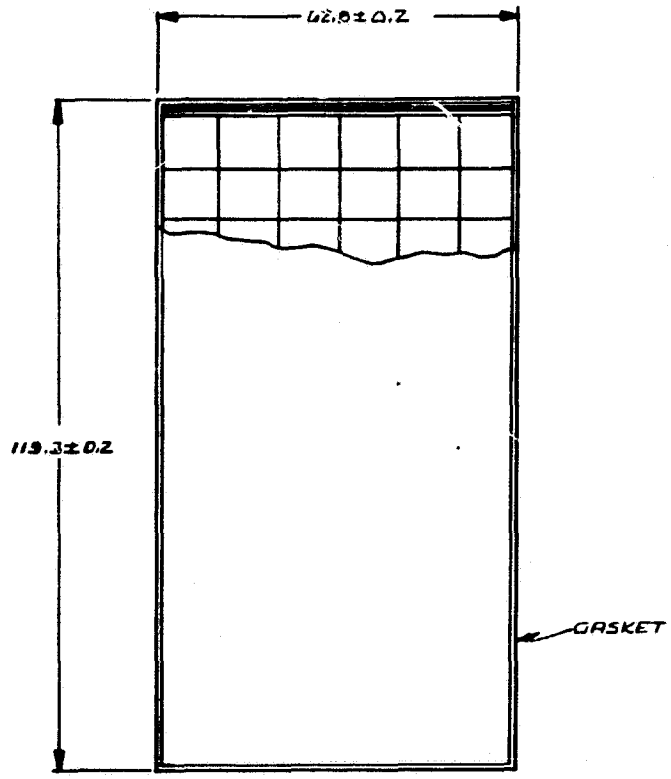
SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

BLOCK III RESIDENTIAL LOAD
TOP ASSEMBLY

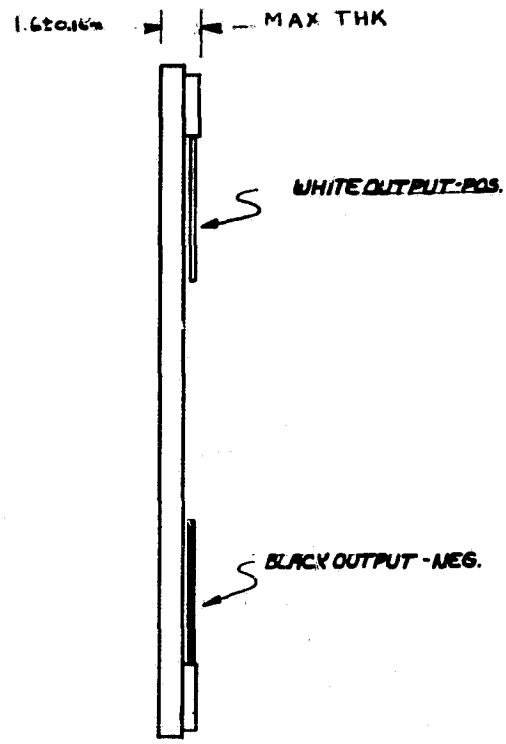
SIZE	CODE IDENT NO	DRAWING NO.
D	RID	0865G

SCALE 1:3 SHEET 1 OF 1

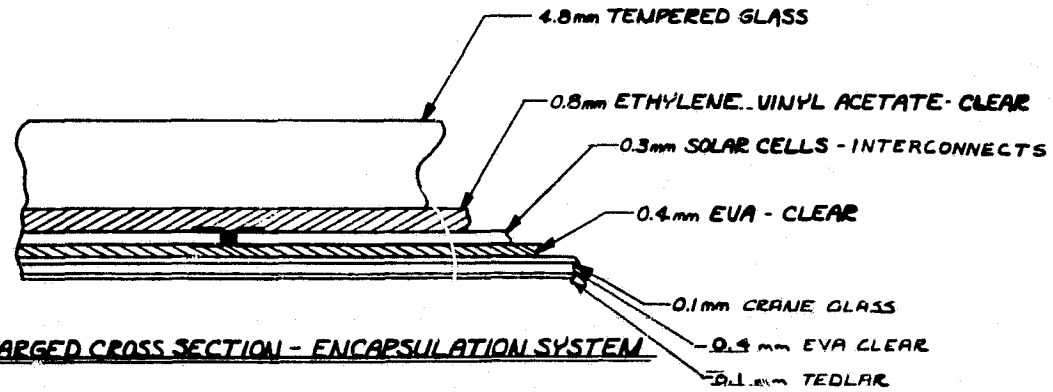
NEXT ASSY	USED ON
APPLICATION	



TOP VIEW



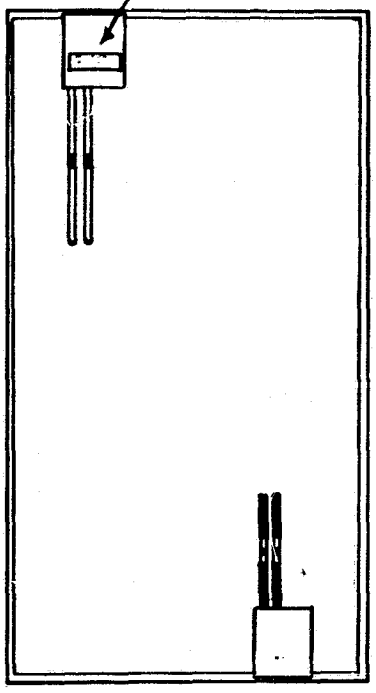
SIDE VIEW



ENLARGED CROSS SECTION - ENCAPSULATION SYSTEM

FOLDOUT FRAME

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	GEN. REVISION	12/04/80	JFH
	B	GEN. REVISION	12/24/80	JFH
	C	GEN. REV.	1/30/81	JFH
	D	ADD PROV. FOR MODIFICATION LABEL	3/2/81	JFH
	E	CHANGE LABEL REV. CONVENTION	3/19/81	JFH



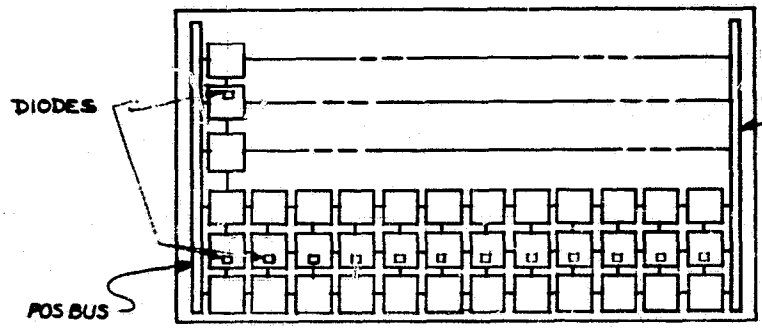
REAR VIEW

NOTES:

1. THE SOLAREX BLOCK IV RESIDENTIAL MODULE HAS NO INTEGRATED FRAME. ONE METHOD OF MOUNTING IS SHOWN HERE.
2. TWO POSITIVE AND NEGATIVE #12 WIRES FROM EACH OF TWO TERMINAL BOXES -- BLACK - NEG. WHITE - POS.
3. ACTIVE (ILLUMINATED) SURFACE DIMENSIONS (WITH 1/2" OVERLAP FOR GASKET) = 59.7 CM X 116.2 CM.
4. MAX WT -- WITHOUT FRAMES = 30 LBS.
5. MODULE SHALL NOT BE TWISTED MORE THAN 1/4" PER FOOT.
6. I.D. LABEL ON POSITIVE TERMINAL BOX. TOP TOWARD SHORT DIM
7. [illegible] SERIAL NO BLOCK ON LABEL REFERS TO SEQUENTIAL NO OF MODULES AND YEAR AND WEEK OF MANUFACTURE.
   XXXXXX = SEQUENTIAL SERIAL NO
   XY = CALENDAR YEAR
   YY = WEEK IN CALENDAR YEAR
8. ALL WIRE LENGTHS -- 30 CM FROM TERMINAL BOX.
9. TWO DIODES PER SIX PARALLELED CELLS.
10. NO SHADOWING WHEN SUN ANGLE IS GREATER THAN 70.2 DEGREES - LONG DIMENSION OR 87 DEGREES - SHORT DIMENSION (GASKET-RUBBER MOLD DESIGN.)

MODEL NO
SBO-BT-R-B 250 V MAX
SERIAL NO
XXXXXX YYZZ
SOLAREX CORP

ID LABEL -



CELL ORIENTATION - BACK VIEW
(NOT TO SCALE)

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN [illegible] CM TOLERANCES ARE: AS STATED
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN P. MEAGHER	12/22/80
CHECKED J.F. [illegible]	12/24/80

Section 7.2

SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

INTERFACE CONTROL
RESIDENTIAL LOAD
BLOCK IV

SIZE	CODE IDENT NO	DRAWING NO.
D	RID	0863E

SCALE [illegible] SHEET / OF 2

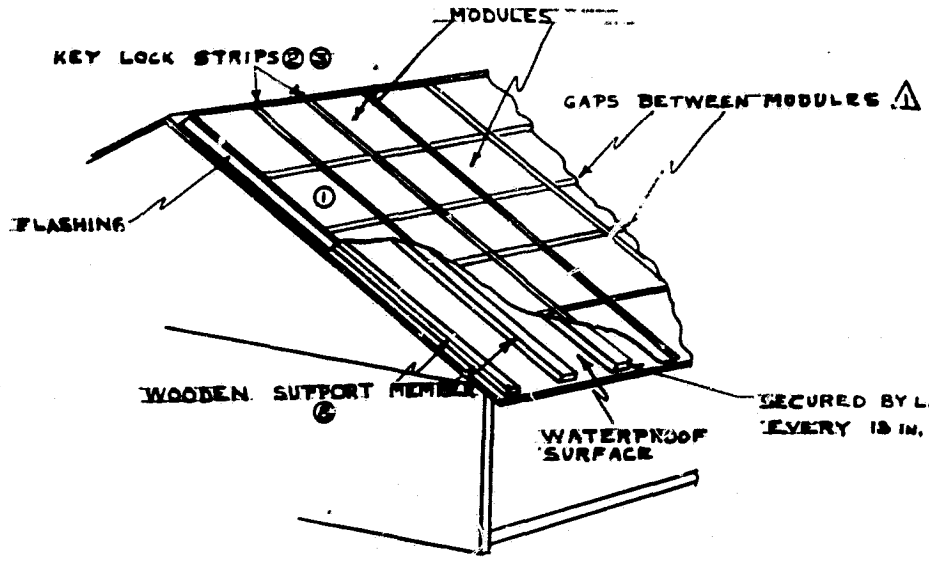
NEXT ASSY	USED ON
APPLICATION	

FOLDOUT FRAME 2

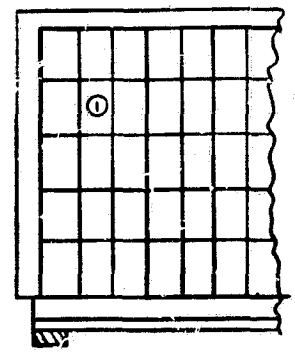
8 7 6 5

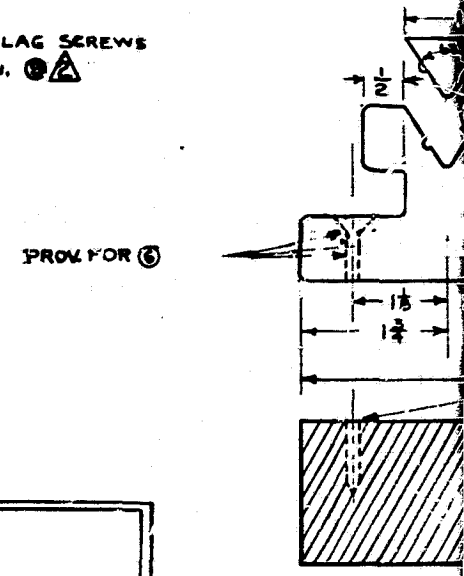
D C B A

MOUNTING CONCEPT

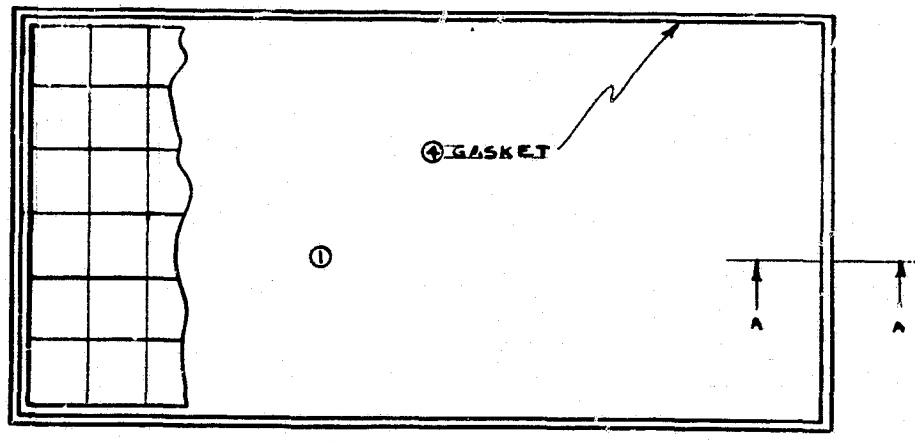


FRONT VIEW

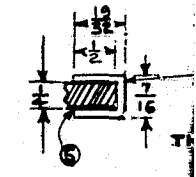




SEC B-B K
AND SUPPOR



TOP VIEW - SHOWING GASKET DIM.



SEC A-A GA

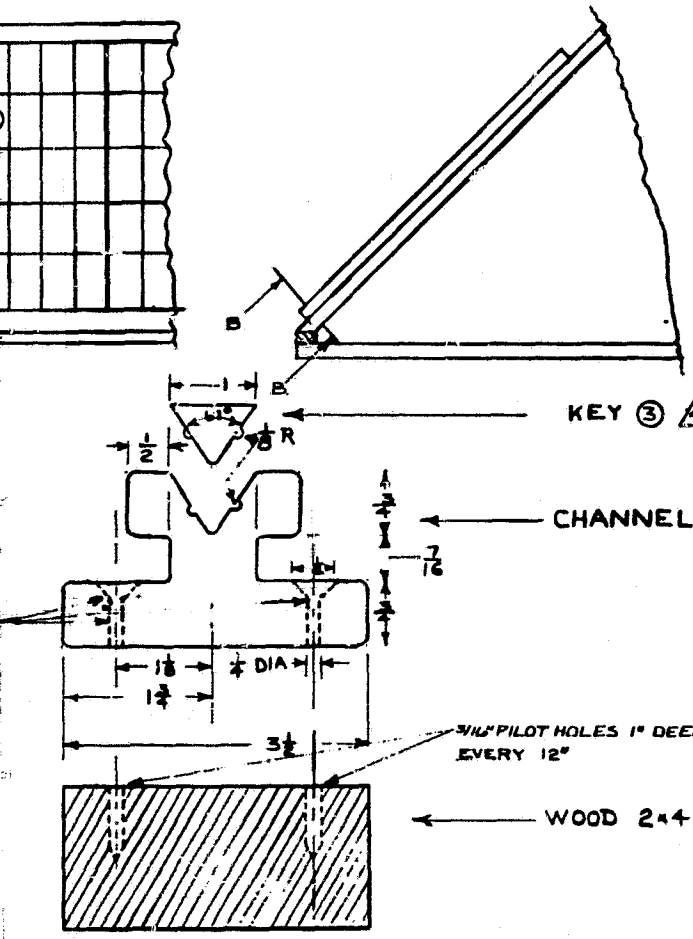
FOLDOUT FRAME

8 7 6 5

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	GEN REVISION	12/24/80	JFH
	B	GEN. REVISION	12/29/80	JFH
	C	GEN. REV.	1/30/81	JFH
	D	ADD PROV. FOR MODIFICATION-LABEL	3/6/81	JFH
	E	CHANGE LABEL REV. CONVENTION	3/19/81	JFH

NT VIEW

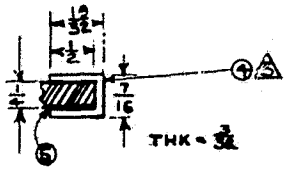
SIDE VIEW



SEC B-B KEY-LOCK AND SUPPORT MEMBER

NOTES:

1. MODULE EDGE ACROSS SHORT DIMENSION DOES NOT REQUIRE KEY-LOCK STRIP. ALLOW 2 IN. GAP BETWEEN ADJOINING MODULE SHORT DIMENSIONS FOR RAIN RUN-OFF.
2. MOUNT 2 x 4 ON 25 11/16 IN. CENTERS.
3. SOURCE FOR GASKET - PAWLING RUBBER COMPANY, PAWLING, NY. SPECIFY GASKET WITH CROSS-SECTION AS SHOWN IN SEC A-A TO FIT O.D. OF 62.2 CM (24 1/2") x 118.7 CM (46 3/4"). MATERIAL HCM 2006 SILICONE COMPOUND 60 DUROMETER.
4. SOURCE FOR KEY-LOCK FABRICATION -- GOODRICH RUBBER COMPANY. SPECIFY STRIPS WITH CROSS-SECTION AS SHOWN IN SEC B-B, LENGTH -- AS REQUIRED FOR APPLICATION. MATERIAL -- EDPM ELASTOMER -- DUPONT TRADE NAME -- NORDEL.



SEC A-A GASKET CROSS-SECTION

	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER
⑥	A/R		3/8" DIA x 2 1/4"	FLAT HEAD ZINC CHROMATE - LAG SCREW - STEEL	
⑥	A/R		SUPPORT MEMBER	CONSTRUCTION GRADE 2"x4"	
⑦	2 PER KEY-LOCK	12.N	1/4 IN DIA LONG	1 3/4 IN. FLAT HEAD ZINC CHROMATE-LAG SCREW STEEL	
⑤	A/R		RTV 108	ADHESIVE - GASKET TO MODULE	G. E.
④	1 PER MODULE			GASKET	PAWLING RUBBER
③	A/R			KEY-LOCK KEY	GOODRICH
②	A/R			KEY-LOCK CHANNEL	GOODRICH
①	A/R		R&D 0863	BLOCK IV RESIDENTIAL TOP ASS'Y	SOLAREX

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32 DECIMALS .XX ± .XXX ± ANGLES ± 2°

MATERIAL: AS STATED

FINISH:

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN J.F.H.J.	2/20/80
CHECKED J.C.H.J.	2/20/80

SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

INTERFACE CONTROL RESIDENTIAL LOAD BLOCK IV

SIZE	CODE IDENT NO.	DRAWING NO.
D	R&D	0863E

SCALE | SHEET 2 OF 2

FOLDOUT FRAME 2

APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED
		A	0864F, 0862E	3-2-81	
		B	0862F, 0864G, D-0928A, C-0929A	3-19-81	

D-0864G Block IV - Intermediate Load
Top Assembly - 2 Sheets

D-0928A-1,
-2 Frame - MIT Lincoln Laboratory

C-0929A L - Bracket - Frame -
MIT Lincoln Laboratory

A-0852A Rear Support Clip

D-0866E Block IV - Intermediate Load
Lamination Assembly

D-0867E Block IV - Intermediate Load
Cell Assembly

*B-0872A Solar Cell Tab Assembly

*B-0813A B-4 Solar Cell Mask

*C-0926 Block IV Interconnect

*C-0927-1,
-2A Block IV Right & Left
Interconnect

*B-0870A Block IV Terminal Box Detail

B-0826C Electrical Schematic - Intermediate Load

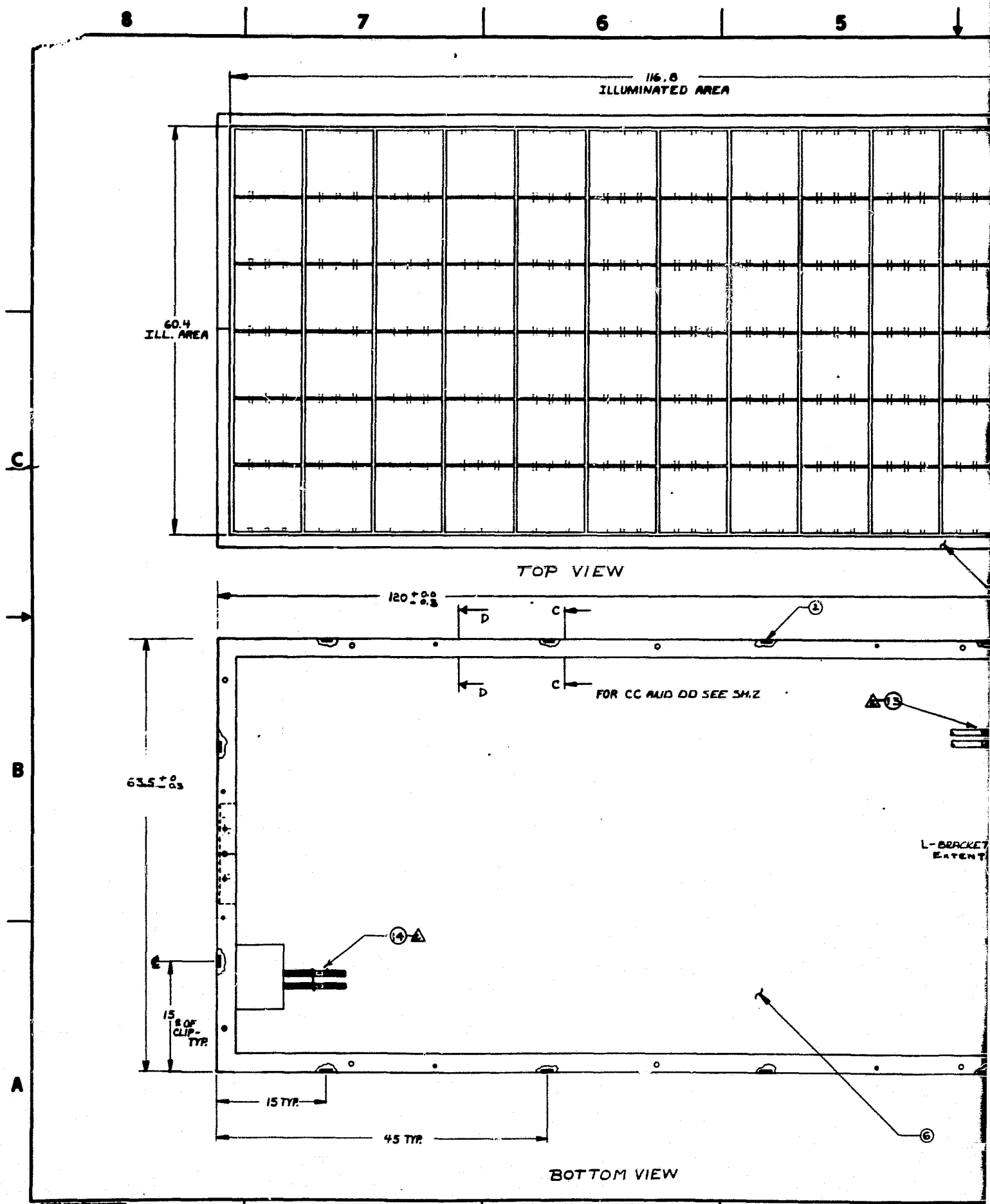
*B-0879 Identification Label

D-0862F Interface Control - Block IV
Intermediate Load

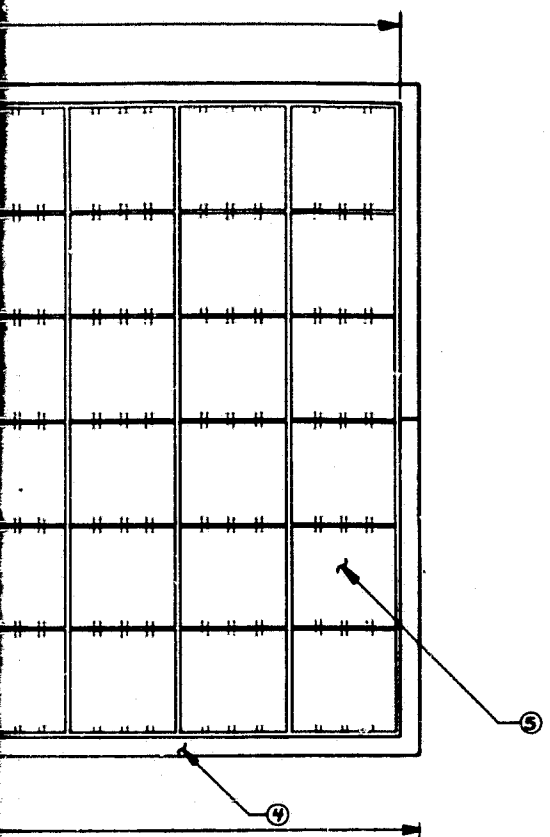
*Applicable to both Residential and Intermediate Load Modules

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±	CONTRACT NO.	SOLAREX CORPORATION 1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202	
	APPROVALS / DATE		
MATERIAL	DRAWN	Block IV Intermediate Load Drawing List	
	CHECKED	19	
FINISH		SIZE: A	CODE IDENT NO.	DRAWING NO.: 580-BT-L-B
DO NOT SCALE DRAWING		SCALE		SHEET OF

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-7270


8
7
6
5
C
B
A
116.8
ILLUMINATED AREA
60.4
ILL. AREA
TOP VIEW
120 +0.0 -0.3
63.5 +0.0 -0.3
D
C
FOR CC AND DD SEE SH.2
L-BRACKET
EXTENT
15
TYP.
15 TYP.
45 TYP.
BOTTOM VIEW
FOLDOUT FRAME

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	GEN REVISION	12/3/79	JFH
	B	GEN REVISION	9/19/79	JFH
	C	GEN. REVISION	11/26/80	JFH
	D	GEN. REVISION	12/29/80	JFH
	E	EXPAND ASS'Y NOT.	1/30/81	JFH
	F	ADD PROV. FOR MODIFICATION-LABEL	3/2/81	JFH
	G	CHANGE ⚠ NOTE	3/19/81	JFH



ASSEMBLY NOTES

Frame assembly- Lay completed lamination assy. (0866) on flat surface (glass side down) place two frame sides (0928-1,-2) around lamination assy. and secure with L-brackets (0929). (End with ground provision is nearest positive terminal). Turn frame- lamination assy. over (glass-up) and lay flat on table allowing tedlar side to rest on frame back. Apply continious bead of RTV-108 on outer 1/2" of glass surface. Turn glass- frame over (glass-side down) and insert rear support clips (0852). Clean excess RTV-108 from glass and frame. Apply white RTV-102 as shown in Sec. D-D.

⚠1 ID LABEL - IN MODEL NO BLOCK-TYPE FOLLOWING INFO:
580-BT-L-W 500 V MAX.
[redacted] W IS REVISION NUMBER OR DRAWING LIST 580-BT-L

IN SERIAL NO BLOCK TYPE FOLLOWING INFO:

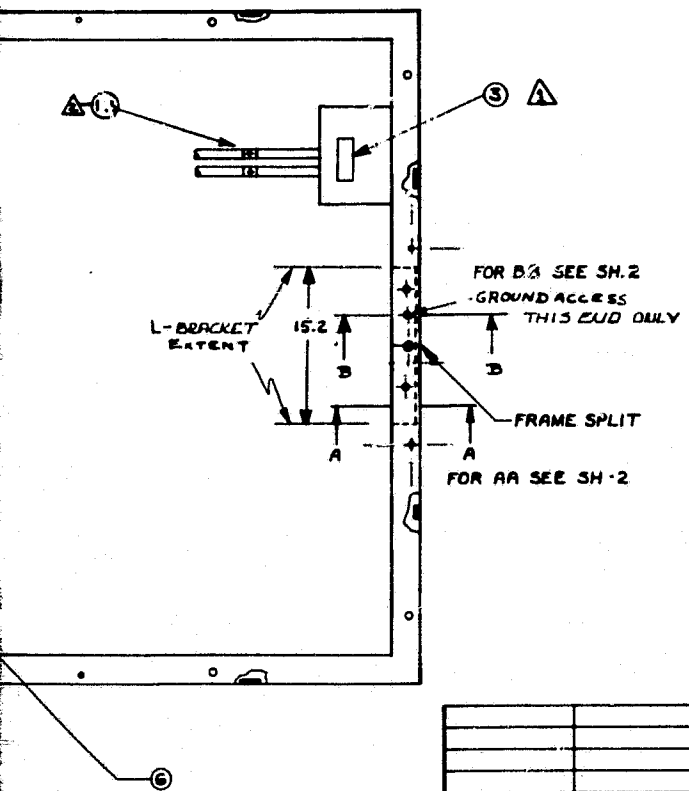
XXXXX - YY - ZZ

XXXXX - NO ASSIGNED FROM SOLAREX MASTER-CONTROL LOG

YY - CALENDAR YEAR

ZZ - SEQUENTIAL WEEK OF YEAR

⚠2 APPLY POLARITY LABELS



NO.	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER
15	AIR			RTV-102 WHITE	G.E.
14	2		LABEL	NEGATIVE	
13	2		LABEL	POSITIVE	
12		AIR	ADHESIVE	RTV 108-CLEAR	GEN. ELECTRIC
11	8		FLAT WASHER	#8-STAINLESS STEEL	
10	1		STARWASHER	#8-STAINLESS STEEL	
9	10		NUTS	#8-32 NC-SS HEX	
8	1		MACHINE SCREW	#8-32-1½ NC-SS 82° FLT HEAD	
7	6		MACHINE SCREW	#8-32-¾ NC-SS 82° FLT HEAD	
6	1		R-D 0866	LAMINATION ASSEMBLY	SOLAREX
4	1		R-D 0928-1,-2	FRAME-MIT LINCOLN LAB.	SOLAREX
3	1		R-D 0879	IDENTIFICATION LABEL	SOLAREX
2	2		R-D 0929	L-BRACKET-FRAME-MIT LINC. LAB.	SOLAREX
1	12		R-D 0852	REAR SUPPORT CLIP	SOLAREX

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN [redacted]
TOLERANCES ARE: CM
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN P. MEAGHER	11/20/79
CHECKED [illegible]	11/-/79

Section 8.1

NEXT ASSY | USED ON
APPLICATION

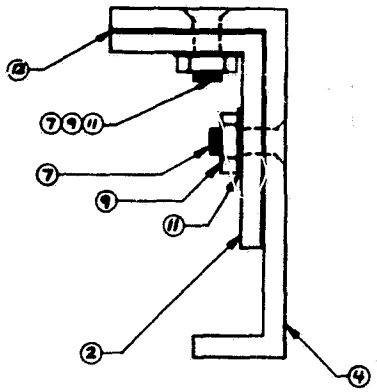
SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

BLOCK III INTERMEDIATE LOAD
TOP ASSEMBLY

SIZE	CODE IDENT NO.	DRAWING NO.
D	RtD	0869G

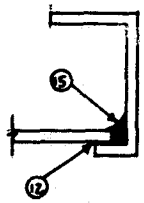
SCALE | SHEET 1 OF 2

FOLDOUT FRAME

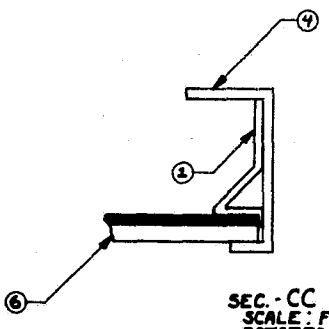


L-SUPPORT ASS'Y
POSITIONED ON ℄ OF FRAME SPLIT

SEC. - AA
SCALE 2:1

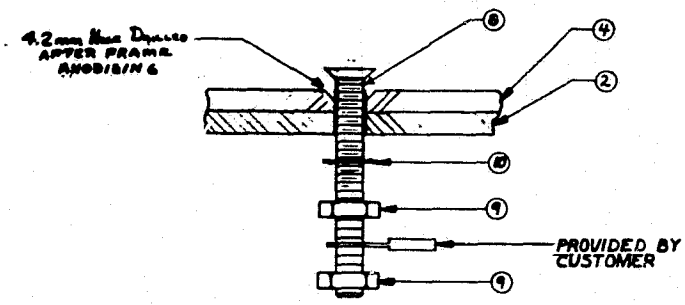


SECTION D-D



SEC. - CC
SCALE : FULL
ROTATED 90° CW

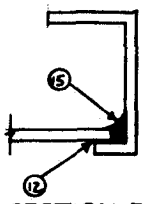
GROUND PROVISION ASS'Y



SEC BB
SCALE 2:1

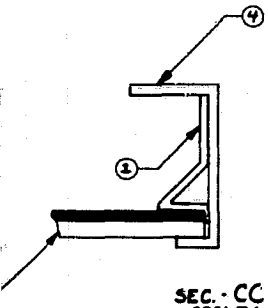
FOLDOUT FRAME

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	GEN REVISION	12/4/79	JFH
	B	GEN REVISION	9/10/80	JFH
	C	GEN. REVISION	11/26/80	JFH
	D	ADD ASS'Y NOTE, SEE D-D	12/30/80	JFH
	E	EXPAND ASS'Y NOTE	1/30/81	JFH
	F	ADD PROV. FOR MODIFICATION - LABEL	3/2/81	JFH
	G	CHANGE ▲ NOTE	3/19/81	JFH



DETAIL SHOWING ADHESIVE AND MODULE-FRAME SEAL

SECTION D-D



REAR SUPPORT CLIP DETAIL TYPICAL INSTALLATION 16 PLACES AS SHOWN

SEC. - CC
SCALE: FULL
ROTATED 90° CW

FOLDOUT FRAME 2

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

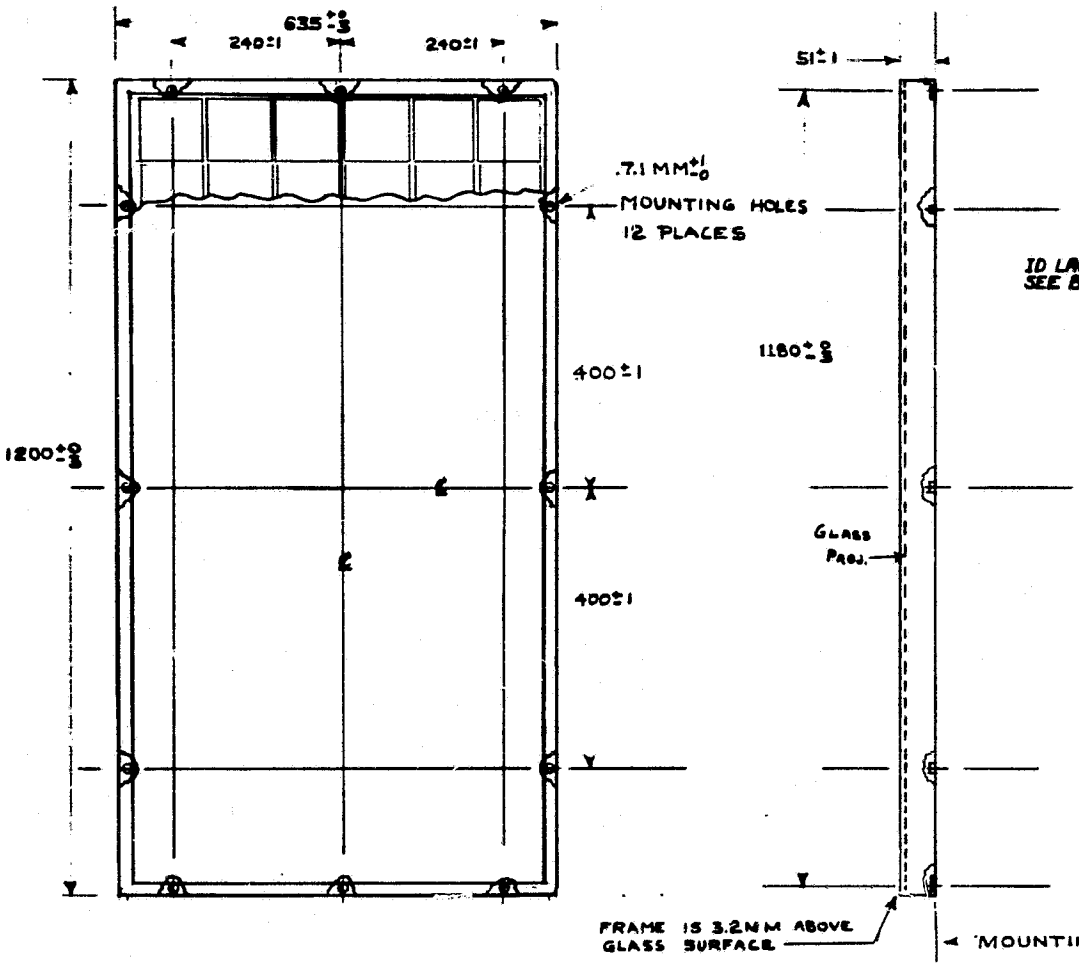
APPROVALS	DATE
DRAWN P. MEAGHER	11/18/79
CHECKED J. Hunt, Jr.	12/3/79

SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

BLOCK III - INTERMEDIATE LOAD TOP ASSEMBLY

SIZE	CODE IDENT NO.	DRAWING NO.
D	RID	08614

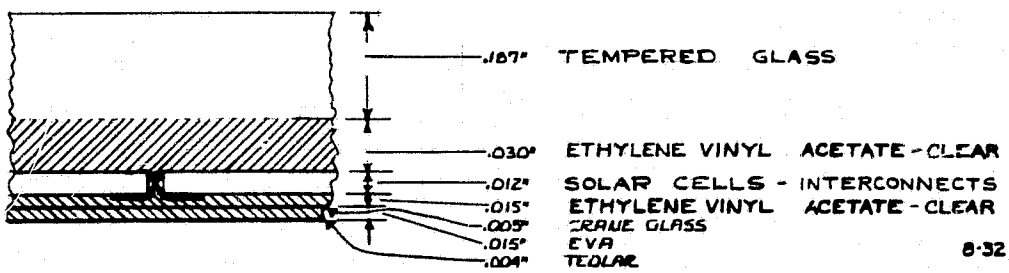
SCALE AS MARKED | SHEET 2 OF 2



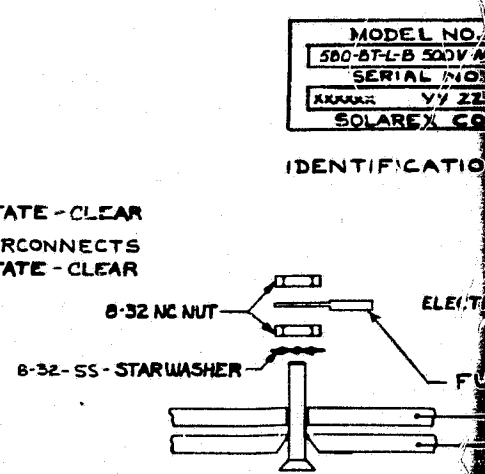
TOP VIEW
VIEW SHOWING THRU-HOLE MOUNTING ON BOTTOM FLANGE

SIDE VIEW
SHOWING ENVELOPE AND PROJECTION ABOVE GLASS SURFACE

REAR
VIEW SHOWING LOC AND GROUNDIN



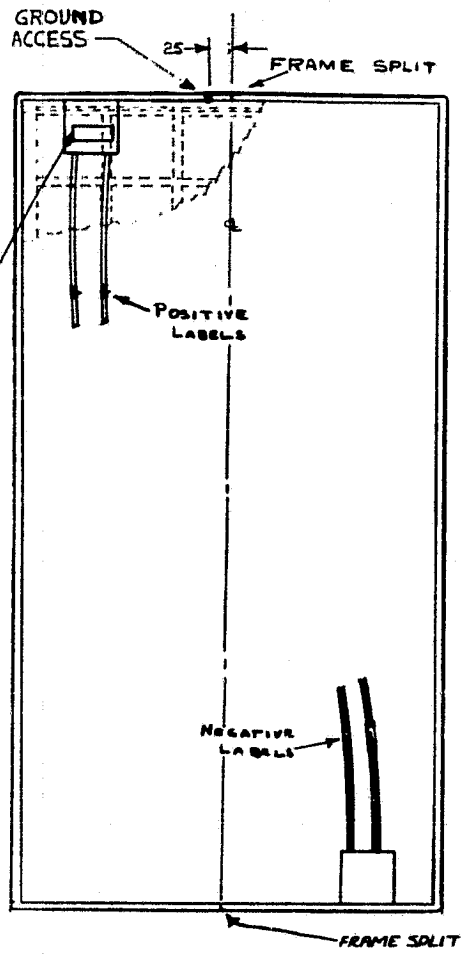
ENLARGED CROSS SECTIONAL — ENCAPSULATION SYSTEM



IDENTIFICATIO

FOLDOUT FRAME

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A.	GENERAL REV.	11/7/80	JFH
	B	GENERAL REV	4/27/80	JFH
	C	GENERAL REV	11/19/80	JFH
	D	CLARIFY NOTES	1/30/81	JFH
	E	ADD PROV FOR MODIFICATION-LABEL	3/2/81	JFH
	F	CHANGE LABEL REV. CONVENTION	3/19/81	JFH



REAR VIEW
VIEW SHOWING LOCATION OF TERMINAL BOXES AND GROUNDING PROVISION

TWO REDUNDANT POSITIVE AND NEGATIVE #14 WIRES FROM EACH OF TWO TERMINAL BOXES BLACK-NEG. WHITE-POS.

ACTIVE (ILLUMINATED) SURFACE DIMENSIONS - 603 MM x 1168MM

NO SHADOWING WHEN SUN ANGLE IS GREATER THAN 41° - LONG DIMENSION OR 45° - SHORT DIMENSION

MAX WT - 35 LBS

MODULE SHALL NOT BE DEFLECTED MORE THAN 20 MM PER METER

ATTACH ELECTRICAL GROUND AS SHOWN - MAX TORQUE 30 IN-LBS

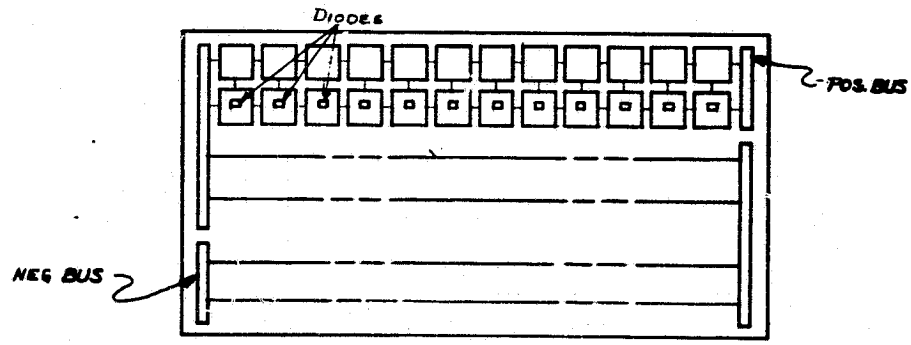
MOUNT WITH #6-32 x 1/4 NC MACHINE SCREW

IDENTIFICATION LABEL ON POS TERMINAL BOX TOP TOWARD SHORT DIMENSION

POS. TERMINAL NEAREST TO GROUND PROVISION-
XXXXXX-SEQUENTIAL SERIAL NO.
YY-CALENDAR YEAR
ZZ-WEEK NO. OF CALENDAR YEAR

ALL WIRE LENGTHS - 30 cm FROM TERMINAL BOX

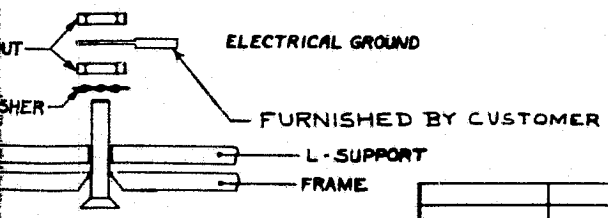
(1) MODEL NO. BLOCK 580-BT-L IS MODEL DESIGNATION -B IS CURRENT REVISION NO. ON DRAWING LIST



CELL ORIENTATION (FROM BACK) (NOT TO SCALE) - 1 DIODE PER TWO PARALLELED CELLS

MODEL NO.
580-BT-L-B 500V MAX.
SERIAL NO.
XXXXXX YY ZZ
SOLAREX CORP

IDENTIFICATION LABEL



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL: FRAME AL ALLOY 6063-T52

FINISH: BLUE ANODIZE

NEXT ASSY | USED ON
APPLICATION
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN	12/3/79
CHECKED	

Section 8.2

SOLAREX CORPORATION
1335 PICCARD DRIVE ROCKVILLE, MD 20850 □ 301 948 0202

INTERFACE CONTROL
BLOCK IV INTER. LOAD

SIZE	CODE IDENT NO.	DRAWING NO.
D	RID	0862F

SCALE | SHEET 1 OF 1

FOLDOUT FRAME

9.0 Conclusions:

Semicrystalline silicon cells were no more difficult to work with than single crystal cells.

The wraparound feature of the tabbing-stringing scheme worked reliably. There had been concern expressed that during lamination the tabs would come in contact with the edge of cells. We have not found that to be a problem.

The in-plane stress relief designed into the interconnect worked well. No interconnect failures were noted in any of the pre-production Block IV modules nor have we noted any interconnect failures in those modules of this design which are in the field.

We learned to work with EVA. Using the experience gained in the Block IV program, Solarex is now routinely making finished panels using EVA.

The crack-tolerant cell design was recognized by JPL when JPL approved the inspection system plan. As many as seven different cells per module could have cracks (some with double cracks) and still be regarded as acceptable.